§23. Piezo Driven Contact for Low Voltage dc Power Supply to Excite Superconducting Coils of Fusion Plant

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FFHR is design study for fusion power plants using a large scale dc superconducting magnet. To keep the coil current, an extra low voltage dc power supply has been studied[1)]. In this power supply, the switching device which is a mechanical contact driven by a piezo device is a key component.

The concept of the piezo-driven contact is shown in Figure 1. Two conductors A and B are put on an isolated plane, and a movement C is put on the piezo actuator. When the piezo actuator is driven, the contact C is pushed down and it bridges the gap between A and B. To confirm this concept, we built a small test device and test the performance[2)].

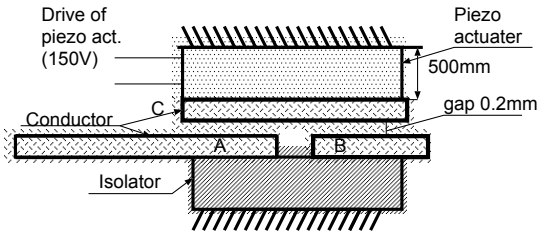


Fig. 1: Mechanical Switch using Piezoelectric Device.

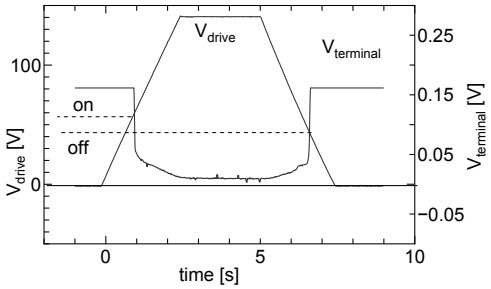
First, we made a steady state experiment to measure the turn on and turn off voltage. The piezo driver is charged and discharged with constant current of 2mA. The main terminal is connected to a current source and the terminal voltage drop is measured and the result is shown in Fig. 2. Fig. 2(a) shows that the conductor turns on at 60V of drive voltage, and it is opened and the turn off voltage is 42.5 V.

Next, the turn on and turn off delay and driven current are measured. Fig. 3 shows turn on characteristics. The drive voltage rises with a time constant of 2.4 ms and it agrees with the time constant calculated with the estimated capacitance and series current limit resistor. The time delay of turn on is estimated to 2ms in this figure and it satisfies the requirement of 20 ms.

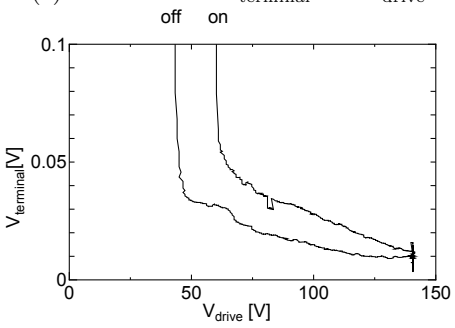
Also turn off characteristics is tested and confirmed that the turn off delay is estimated less than 1 ms.

1)CHIKARAISHI H., et al: 15th European Conference on Power Electronics and Applications ,Lile, France, (2013) .

2)CHIKARAISHI H.: "Extra Low Voltage Dc Power supply for Large Scale Superconducting Coil for Fusion device", , accepted for IEEE Trans on ASC.

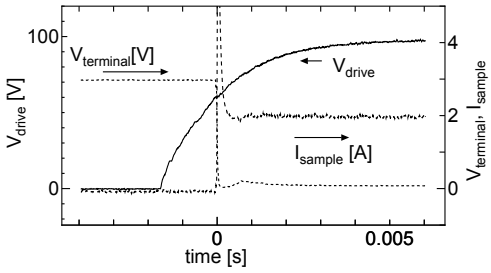


(a) Waveforms of V_{terminal} and V_{drive}

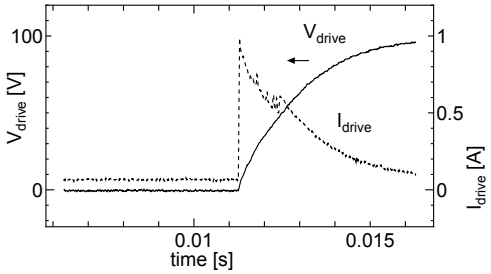


(b) Plots of V_{terminal} vs V_{drive}

Fig. 2: Drive Voltage and Terminal Voltage of Steady State Test.



(a) Drive voltage and terminal voltage



(b) Drive current.

Fig. 3: Drive and Terminal Voltage and Drive Current at Turn On.